Health Care Delivery

Patterns of Antibiotic Use in a Busy Metropolitan Emergency Room:

Analysis of Efficacy and Cost-Appropriateness

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Antibiotics account for 15 percent to 20 percent of all new and refill prescriptions issued in ambulatory community practice. Antibiotic-prescribing practices in our emergency room for common outpatient infections—pharyngitis, bronchitis, sinusitis, otitis media, cellulitis, cutaneous abscesses and pneumonia—were evaluated. Antibiotic selection was compared with recommendations representing current standards for care, and the cost of each was approximated. Antibiotic agents were judged to be overused in patients with pharyngitis, bronchitis and cutaneous abscesses. Patients who had acute sinusitis and otitis media often did not receive antibiotics or received an antibiotic not active against Hemophilus influenzae. *A simple audit of antimicrobial drug usage for common outpatient infections proved to be a cost-effective way to identify excessive or inappropriate drug use. This approach could be used for evaluating the use of other drugs, and the results of these evaluations could serve to focus continuing educational programs.*

Antibiotics are among the most commonly prescribed classes of drugs. They account for 15 percent to 20 percent of all new and refill prescriptions issued in ambulatory community practice,[1] whereas about 30 percent of patients in hospital receive antibiotics whether they are admitted to community[2] or to university hospitals.[3,4] Evaluation of appropriateness of antibiotic use has focused primarily on patients admitted to hospital. In studies of inpatients, there has been little difference between community hospitals, where 62 percent of patients receiving antibiotics failed to have definite evidence of infection,[2] and university hospitals, where 64 percent of total antibiotic therapy was judged as not indicated or inappropriately administered in terms of drug or dosage.[3] Unnecessary therapy, poor drug choice or misguided prophylaxis was cited in one study in which the rate of inappropriate antibiotic administration was 41 percent.[4]

The use of antibiotics for problems in ambulatory patients has not been as thoroughly analyzed, but United States marketing research data indicate that 95 percent of physicians issue one or more prescriptions to a patient diagnosed as having the "common cold" and almost 60 percent of the prescriptions are for antibiotics.[1] The potential consequences of such practices include not only unnecessary risk from drug reactions, sensitization to antibiotic agents that may be required later and overgrowth of a resistant strain, but also excessive and unnecessary cost.

In an attempt to evaluate antibiotic-prescribing practices in our emergency room and ascertain the cost of this treatment, we reviewed patterns of antibiotic usage for common outpatient infections. The charts of all patients treated by house staff and attending physicians in a metropolitan university-affiliated hospital emergency room who had a discharge diagnosis of pharyn-

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gitis, bronchitis, sinusitis, otitis media, cellulitis, cutaneous abscesses or pneumonia were reviewed. Actual antibiotic selection was compared with recommendations representing current standards for care, and the relative costs of each were determined.

Methods

Background

San Francisco General Hospital Medical Center is a 600-bed acute care public hospital that serves as a major teaching hospital for the University of California, San Francisco. The adult emergency area is used by about 200 patients a day in three different areas: medical, surgical and ambulatory drop-in. These areas are staffed by medical students and interns under the supervision of medical and surgical residents and attending physicians. All cases are evaluated by either a resident or an attending physician.

Data Collection

A computer system was used to retrieve charts of patients who had discharge diagnoses of pharyngitis, bronchitis, sinusitis, otitis media, cellulitis, cutaneous abscess or pneumonia from July 1, 1980, to November 30, 1980. A random sample of charts with each diagnosis was then evaluated for age, allergies, underlying illness, treatment and other pertinent information depending on the diagnosis—for example, whether or not a throat culture was done when there was a discharge diagnosis of pharyngitis. The basis of the discharge diagnosis was not evaluated.

Standard of Care Criteria

The following criteria for treatment of the specific infections were established by a review of the current medical literature. Penicillin is regarded as the therapy of choice for group A streptococcal pharyngitis. This treatment prevents acute rheumatic fever, parapharyngeal abscesses and suppurative adenitis, though it has little effect on the natural course of the illness.[5] It is difficult on clinical grounds to differentiate group A streptococcal pharyngitis from pharyngitis caused by viruses or *Mycoplasma pneumoniae,*[6] and because only 20 percent to 25 percent of cases of pharyngitis are caused by group A streptococci, it is recommended that results of a throat culture dictate whether or not antibiotics should be used.

The choice of an antibiotic for the ambulatory treatment of pneumonia should depend on the bacteria causing the infection. A proper Gram's stain of a carefully collected specimen of expectorated sputum is the most rapid method of predicting the bacteria causing the pneumonia.[7] Treatment with penicillin is a reasonable choice if a Gram's stain shows a predominance of Gram-positive lancet-shaped diplococci indicating *Streptococcus pneumoniae,* or ampicillin if a Gram's stain shows either a predominance of Gram-negative coccobacillary forms suggesting *Hemophilus influenzae* infection or a mixture of both forms. Erythromycin is active against *S pneumoniae,* which causes pneumonia in all age groups. It is also active against *M pneumoniae,* which frequently causes pneumonia in older children and young adults.[8] Thus, if a sputum specimen cannot be obtained in a patient with pneumonia who is younger than 40 years of age (in whom *H influenzae* pneumonia is rare), erythromycin treatment is a rational choice. In patients older than 40 years of age who have community-acquired pneumonia, the choice of an antibiotic, if sputum cannot be obtained for Gram's stain, is more difficult. Older studies of community-acquired pneumonia derived much of their data of bacterial cause from the results of sputum cultures.[9,10] Since these studies were carried out, sputum cultures have been shown to be an unreliable way of determining the bacterial cause of pulmonary infections.[11] Although *H influenzae* appears to be an agent more commonly causing pneumonia in older patients who have chronic bronchitis than previously appreciated,[12] its incidence in the general population has not been determined. Erythromycin is not consistently active against *H influenzae* in achievable serum concentrations. We cannot yet make a firm recommendation for the choice of an antibiotic in the outpatient management of community-acquired pneumonia in patients older than 40 years of age when sputum cannot be obtained for Gram's staining. Given the current state of knowledge and the low incidence of β-lactamase-producing *H influenzae* in our population (5 percent), ampicillin would probably be the appropriate choice.

A diagnosis of acute bronchitis is made when a patient presents with a cough and purulent sputum production, and no abnormalities are found on a chest roentgenogram. Patients who have a diagnosis of acute bronchitis and a history of chronic pulmonary disease —most of whom are older than 40 years of age— benefit from the use of antibiotics, but otherwise healthy people do not.[13] The presence of cough and purulent sputum and the amount of time away from work are similar in patients without a history of chronic pulmonary disease whether or not they are treated with antibiotics.

Acute sinusitis and otitis media in adults and children are caused by a variety of aerobic and anaerobic bacteria of which *S pneumoniae* and *H influenzae* are by far the most frequently found.[14,15] Therapy aimed at these two agents has been shown to be effective.[16] Ampicillin or amoxicillin trihydrate and trimethoprim-sulfamethoxazole in a penicillin-allergic patient reach serum concentrations that are active against most of these organisms and represent rational treatment for acute sinusitis or otitis media.

Surgical drainage of localized cutaneous abscesses is the treatment of choice and antibiotics are generally of little value in patients with normal host defenses.[17] Because *Staphylococcus aureus* is the most common cause of cutaneous abscesses, however, it would be important to choose an agent active against this organism when there is enough toxicity or associated cellulitis to warrant antibiotic administration.

The bacterial cause of cellulitis may not always be

TABLE 1.—*Evaluation of Therapy*

Diagnosis	*Number of Patients*	*Most Important Treatable Pathogens*	*Therapy of Choice*	*Percentage Treated Incorrectly**
Pharyngitis	50	Group A streptococci	Penicillin	50†
Ambulatory pneumonia	27	*Streptococcus pneumoniae* *Mycoplasma pneumoniae* *Hemophilus influenzae*	Penicillin,‡ ampicillin, erythromycin	0
Bronchitis	106	Mixed flora	Tetracycline, ampicillin, erythromycin	50§
Sinusitis	24	*S pneumoniae* *H influenzae*	Ampicillin, trimethoprim-sulfamethoxazole	79
Otitis media	26	*S pneumoniae* *H influenzae*	Ampicillin, trimethoprim-sufamethoxazole	88
Cutaneous abscesses	39	*Staphylococcus aureus*	Incision and drainage	49‖
Cellulitis	31	Streptococci *S aureus*	? Penicillin vs dicloxacillin	0

*Treated with antimicrobial agents that would not be expected to be effective against the major treatable pathogens.
†Treated before knowing results of throat culture.
‡Choice of antibiotic dependent on findings of Gram's stain.
§Antibiotic therapy indicated only in patients who have a history of chronic pulmonary disease.
‖Received antibiotics in addition to incision and drainage.

clear from physical examination of the involved area.[18,19] Although a well-marginated, raised, brightly erythematous area of infection usually represents infection caused by a group A streptococcus, *S aureus* has occasionally been implicated in similar-appearing lesions. A recent study of 20 children who had cellulitis found *S aureus* in cultures of eight wound aspirates.[20] It is therefore rational to treat cellulitis with an agent active against both *S aureus* and group A streptococci, especially when it involves the face where the consequences of inappropriate therapy might be devastating. However, the vast majority of cases of typical erysipelas of the extremities respond to penicillin or, in a penicillin-allergic patient, erythromycin. The presence of pus should dictate the administration of antistaphylococcal drugs such as dicloxacillin sodium or cloxacillin sodium.

Results

Patterns of Antimicrobial Drug Use

In all, 50 cases in which a discharge diagnosis of pharyngitis was made were evaluated (Table 1). Although 47 patients (94 percent) had a throat culture done initially for group A streptococci, half were treated with penicillin before culture results were obtained. These patients were told to call the hospital to find out the culture results and whether or not to discontinue therapy.

There were 27 cases of roentgenographically proved pneumonia in which ambulatory patients were treated. When a sputum Gram's stain showed Gram-positive diplococci in six patients, a presumptive diagnosis of pneumococcal pneumonia was made and the patients were given penicillin. Ampicillin was given to four patients when a sputum Gram's stain showed mixed flora. Erythromycin was used in all patients who could not produce sputum. (This pattern did not vary in the 11 patients older than 40 years of age for whom *M pneumoniae* is presumably not an important cause of pneumonia.)

Patients with a discharge diagnosis of bronchitis were treated the same whether they were young and healthy or had a history of either chronic bronchitis or obstructive pulmonary disease or both. Of 59 patients younger than 40 years of age, 50 (85 percent) received antibiotics, and of 47 older than 40 years of age, 40 (85 percent) received antibiotics. Therefore, at least 50 percent—and probably a much higher proportion—of patients received inappropriate and unnecessary treatment. The choice of an antibiotic was almost evenly divided among erythromycin, ampicillin and tetracycline.

Of 24 adults with a clinical diagnosis of acute sinusitis, only 13 (54 percent) received antibiotics. Penicillin was prescribed for three, erythromycin for four, ampicillin for five and tetracycline for one. Two of the four patients given erythromycin had a history of penicillin allergy.

Of 26 adults with acute otitis media, 16 (62 percent) received antibiotics. Ten received penicillin, two erythromycin and two ampicillin. Of the three patients with a history of penicillin allergy, two received erythromycin and one received trimethoprim-sulfamethoxazole.

Of 39 patients with cutaneous abscesses, 33 (85 percent) required surgical drainage. Oral antibiotics were also administered to 19 patients: eight received penicillin, nine dicloxacillin, one erythromycin and one cephalexin.

Of 31 patients with nonfacial cellulitis, 30 (97 percent) received antibiotics. Of these, 16 were treated with penicillin, 10 with dicloxacillin and 4 with erythromycin. All four patients who received erythromycin had a history of penicillin allergy.

Cost of Antimicrobial Drug Therapy

The cost of the different antimicrobial agents used is shown in Table 2. Note the considerable differences both among different antibiotics and different preparations of the same antibiotic. There was also a large

TABLE 2.—*Cost of Antimicrobial Drugs*

Antimicrobial Drug	*Number of Different Preparations Available*	*High**	*Low**	*Average Cost**	*Cost at SFGHMC†*
Ampicillin 250 mg	32	$10.00	$ 4.50	$ 6.42	$ 4.00
Ampicillin 500 mg	29	27.50	8.95	12.42	7.00
Erythromycin 250 mg	31	14.95	6.10	8.51	4.00
Erythromycin 500 mg	13	25.90	12.95	17.19	...
Penicillin V 250 mg	10	4.75	2.30	3.37	2.00
Penicillin V 500 mg	6	9.50	4.50	6.59	4.00
Dicloxacillin sodium 250 mg	3	54.86	26.90	39.26	9.00
Dicloxacillin sodium 500 mg	2	85.84	46.40	66.12	18.00
Sulfamethoxazole-trimethroprim 160 mg/800 mg	2	38.04	37.25	37.65	5.00
Tetracycline 250 mg	26	4.00	1.95	2.78	2.00
Tetracycline 500 mg	25	6.04	3.60	4.64	6.00

*Cost of 100 tablets to the pharmacy, based cn *American Druggist Blue Book,* 1981-1982 edition.

†Cost of 100 tablets to the San Francisco General Hospital Medical Center Pharmacy, where antibiotics are purchased on a bid system.

variation in cost depending on how the drugs are purchased. At large institutions, antibiotics are usually purchased directly from a manufacturer using a bid system, which can result in large savings. For smaller institutions and individual pharmacies, the cost is usually greater; antibiotics are sometimes purchased through a wholesaler—who adds 15 percent to 20 percent—and not directly from a manufacturer.

Discussion

This study reveals surprising inconsistencies in patterns of antibiotic use for commonly encountered outpatient problems. In many cases patients were administered antibiotics unnecessarily or were given antibiotics that were not active against the major pathogens causing their infectious disease. Unnecessary use of antibiotics is expensive and potentially dangerous. Antibiotics may alter a patient's endogenous flora and favor the development or emergence of resistant strains or the acquisition of new strains with multiple antimicrobial resistance. Antibiotic use may also result in allergic or other serious side effects.

Half of our patients who had pharyngitis were treated with penicillin before throat culture results were available. A rational and time-saving approach is to write a prescription for penicillin, tell the patient why it is necessary to take the drug if his or her infection is caused by group A streptococci and have the patient call the next day for results. If the culture is positive, the patient should have the prescription filled and take the antibiotic. This approach minimizes unnecessary drug exposure and expense.

Pneumonia was treated with penicillin if a Gram's stain showed a predominance of Gram-positive diplococci indicating *S pneumoniae,* ampicillin if the Gram-stained flora were mixed, raising the possibility of either *S pneumoniae* or *H influenzae* infection, and erythromycin if no sputum could be obtained. Based on our evaluation of available data, this appears to be a rational and safe approach to antibiotic treatment of pneumonia in outpatients, though ampicillin would also be a good choice for patients older than 40 years of age when sputum cannot be obtained for Gram's staining.

Essentially all patients who had a diagnosis of acute bronchitis, including 85 percent of patients younger than 40 years, received antibiotics. About half of these patients were healthy and had no smoking history. Because healthy persons with cough and purulent sputum production do not benefit from antibiotic administration, such therapy in these cases must be judged as unwarranted.

In our series only 21 percent of patients who had acute sinusitis received an antibiotic active against both *H influenzae* and *S pneumoniae,* whereas 46 percent received no antibiotic. The bacterial organisms most frequently found in adults with acute otitis media are also *S pneumoniae* and *H influenzae;* yet only 12 percent of the patients in whom this diagnosis was made received ampicillin or trimethoprim-sulfamethoxazole, agents active against these organisms; 38 percent received no antibiotic.

Antibiotic treatment of localized cutaneous abscesses was also excessive. Of our patients with localized abscesses, 85 percent were treated with surgical drainage, but 49 percent also received antibiotics, which in patients with normal host defenses is usually unnecessary. Because *S aureus* is frequently found in abscesses, it would seem logical to choose an agent active against this organism if treatment with an antibiotic is considered necessary. Only 58 percent of the antibiotic regimens prescribed, however, included such an agent.

Treatment of nonfacial cellulitis reflected the indecision about the causative role of *S aureus* mirroring the different recommendations in standard infectious disease and dermatologic textbooks.[18,19] In all, 47 percent of patients were treated with regimens active against this organism, whereas the remainder received only penicillin, which was presumably prescribed for *Streptococcus pyogenes.*

Recently the rapidly rising cost of health care has begun to be scrutinized. During the 1970s, national

health expenditures more than doubled, with an average annual increase of 12.6 percent. During the past two decades, national health care expenditures increased from 4.5 percent of the Gross National Product in 1960 to 9.1 percent in 1978.[21] A large proportion of health care funds is spent for medicine, both inside and outside the hospital, and antibiotics comprise the single largest drug expense item, accounting for 33 percent of the national expenditure for drugs.[22]

Our study identified several potential areas in which antibiotic use could be modified to minimize the use of unnecessary antibiotics and health care costs. Antibiotics were overused in patients who had pharyngitis, bronchitis and cutaneous abscesses. In our hospital, of 30 patients per month seen in the emergency room with cutaneous abscesses, approximately a third were given an inappropriate course of dicloxacillin. Because each ten-day course of dicloxacillin (250 mg four times a day) costs $7.20, this can result in a potential savings per month for ten patients of $72. The average cost to a pharmacy for a ten-day course of the same dosage of dicloxacillin is $15.70, or $18.05 to $18.89 if purchased from a wholesaler. The actual cost to a patient or health insurer is higher because of the pharmacy's fee for filling the prescription. About 60 patients with pharyngitis are seen in our emergency room per month. Half of the patients are treated with penicillin before throat culture results are available. Because only 20 percent of throat cultures are positive, 24 patients fill an unnecessary prescription for penicillin (250 mg four times a day) that costs $4.40 for a ten-day supply, a potential savings of $105.60 per month. Half of the 40 patients per month diagnosed as having bronchitis received an unnecessary course of antibiotics. If all were given ampicillin (500 mg four times a day), this would result in a potential savings of $128 a month in our hospital; the costs of erythromycin and tetracycline would be similar. All of these figures, of course, are without a pharmacy's or a wholesaler's additional fee.

In addition, in situations in which different antibiotics are equally efficacious, it seems reasonable to prescribe the least expensive antibiotic. Given the twofold to threefold differences in cost among pharmacies between tetracycline and ampicillin or erythromyin, the potential savings are considerable when choosing an antibiotic to treat a patient who has chronic pulmonary disease and acute bronchitis. A similar point can be made regarding the choice of ampicillin versus trimethoprim-sulfamethoxazole for the treatment of either sinusitis or otitis media. Penicillin V is 12 times less expensive than dicloxacillin, and thus a study to determine the relative importance of *S pyogenes* versus *S aureus* as the causative agent in cellulitis in adults could be justified on a cost basis alone.

The information presented herein shows the need for continuing surveillance of antibiotic-prescribing practices. This study and others[4,23] point to the need to educate physicians further about the basic principles of clinical infectious diseases, particularly antibiotic selection, based on what is known of the bacterial causes of different conditions. When appropriate, the cost of different drug regimens should be taken into consideration in prescribing antibiotics. Correcting the over-prescribing of antibiotics for commonly encountered outpatient infections could result in considerable savings not only to patients but also to health insurers or society when the government is the insurer.

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